PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-153579

(43)Date of publication of application : 23.05.2003

(51)Int.Cl. H02P 6/12
H02P 7/63
H02P 21/00

(21)Application number : 2001-350145

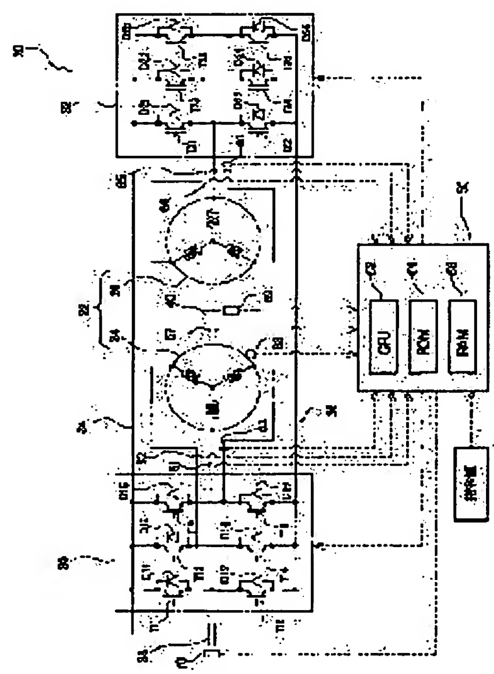
(22)Date of filing : 15.11.2001

(71)Applicant : TOYOTA CENTRAL RES & DEV LAB INC
TOYOTA MOTOR CORP

(72)Inventor : NAKAI HIDEO
MORIYA KAZUNARI
OTANI HIROKI
INAGUMA YUKIO
ARAKAWA TOSHIFUMI
OTANI HIROKO
SHIYAMOTO SUMIKAZU
KOMATSU MASAYUKI

(54) MOTOR DRIVE CONTROL APPARATUS AND METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To maintain appropriate operation by the drive of other arms, even in the failure of an inverter arm.
SOLUTION: Inverter circuits 30 and 32 supply a current to motor coils 24 and 26, respectively. When the arm of the inverter circuits 30 and 32 fails (for example, a series of two transistors) and no current can be outputted, the current output from other arms is controlled, so that the output of the failed arm is compensated, thus inhibiting the generation of torque ripples of the motor 22, and preventing the adverse effects to the current between the neutral points which are located between the two motor coils 24 and 26 for supplying current.



LEGAL STATUS

[Date of request for examination] 17.05.2004

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

CLAIMS

[Claim(s)]
[Claim 1] It has two motor coils of the independent star to one Rota. It is the motorised control unit which drives the motor which connected between the neutral points of these motor coil through DC power supply. Two inverters which have two or more arms connected to two or more edges of the motor coil with which it is prepared corresponding to said two motor coils, and each corresponds, It has the control circuit which controls actuation of each arm of these two inverters. Said control circuit When at least one of said the arms breaks down and it becomes impossible to output a current, while controlling other arms and maintaining rotation of the current in two motor coils The motorised control unit which controls the arm in two inverters in agreement with the current with which the current which flows out of the neutral point of one motor coil flows into the motor coil of another side.
[Claim 2] Said two motor coils are motorised control units with which only a predetermined include angle can shift a phase in equipment according to claim 1, and it is arranged.
[Claim 3] In equipment according to claim 2 said two motor coils It is formed from the coil of a three phase with which 120 degrees of phases differ at a time mutually, respectively. a1, a2, a3, and the position vector of those for the current which flows in one coil (cos0, sin0), (cos120, sin120), (cos240, sin240), a1, a2, a3, and the position vector of those for the current which flows in the coil of another side Moreover, (cosq, sinq), (cos (q+120), sin (q+120)) (it cos(es) (q+240)), It is referred to as sin (q+240), and q is the phase contrast between both motor coils here. The unit of said trigonometric function The motorised control unit which is **, sets to 0 the current and position vector of a coil corresponding to the arm which broke down in three lower formulas on this condition, and determines the current of other coils.
[Equation 1] a1cos0+a2cos120+a3cos240+b1cosq+b2cos(q+120)+b3cos(q+240)=rcos(wt)
a1sin0+a2sin120+a3sin240+b1sinq+b2sin(q+120)+b3sin(q+240)=rsin(wt)
a1+a2+a3=-(b1+b2+b3
However, the angular rate of rotation as an electrical angle of Rota and t of the magnitude of the current component which r commits effective in a motor output torque, and w are time amount.
[Claim 4] The 1st three-phase-motor coil controlled by the 1st inverter, and the 2nd three-phase-motor coil controlled by the 2nd inverter, It has the capacitor which gives power to said 1st and 2nd inverters, and the power source connected at the neutral point of said 1st and 2nd three-phase-motor coils. In the motorised control unit equipped with the converter ability which carries out step-down and step-up of said supply voltage by controlling said 1st and 2nd inverters, and carries out adjustable [of the electrical potential difference of a capacitor], in order to realize a desired motorised current The relation required of the current value of each phase of said 1st and 2nd three-phase-motor coils, It has an operation means to calculate each phase current value with which both relation required of the current value of each phase of said 1st and 2nd three-phase-motor coils in order to realize desired step-down and step-up is filled based on a predetermined matrix. The motorised control unit which transforms said predetermined matrix so that there may be no current of the broken phase and a desired motorised current and the current for step-down and step-up may be outputted from said 1st and 2nd inverters, when one of said each phases breaks down.
[Claim 5] It is the motorised control unit with which said 1st three-phase-motor coil and said 2nd three-phase-motor coil form the double winding motor in equipment according to claim 4.
[Claim 6] The motorised control unit which sets up highly the target electrical potential difference of step-down-and-step-up control in equipment according to claim 4 or 5 when said failure is detected.
[Claim 7] The motorised control unit with which said 1st three-phase-motor coil and the 2nd three-phase-motor coil are arranged in equipment according to claim 5 by the angular difference of values other than 0 times or 60 degrees.

[Claim 8] It has two motor coils of the independent star to one Rota. It is the motorised control approach of driving the motor which connected between the neutral points of these motor coil through DC power supply. It is prepared corresponding to said two motor coils, and actuation of each arm of two inverters which have two or more arms connected to two or more edges of the motor coil with which each corresponds is controlled. While supplying a desired motorised current to two motor coils, when at least one of said the arms breaks down and it becomes impossible to output a current The motorised control approach which controls the arm in two inverters in agreement with the current with which the current which flows out of the neutral point of one motor coil flows into the motor coil of another side while controlling other arms and maintaining rotation of the current in two motor coils.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention has two motor coils of the independent star to one Rota, and relates to the motorised control unit which drives the motor which connected between the neutral points of these motor coil through the power source, and its approach.
[0002]
[Description of the Prior Art] Conventionally, the three-phase-alternating-current motor of a star is known, and the inverter circuit is widely used for supply of the motorised current to this three-phase-alternating-current motor. In the usual case, DC power supply are connected between the positive-electrode bus-bar of an inverter circuit, or a negative-electrode bus-bar, and by the inverter circuit, the direct current power from these DC power supply is changed into a desired three-phase-alternating-current current, and is supplied to a motor.
[0003] Here, the thing equipped with the DC power supply connected at the capacitor, the positive-electrode bus-bar of an inverter circuit or negative-electrode bus-bar connected to the positive-electrode bus-bar and negative-electrode bus-bar of the inverter circuit which impresses the three-phase alternating current to a motor, and the neutral point of a motor is proposed (for example, JP,10-337047,A, JP,11-178114,A, etc.). Time sharing shall realize actuation operated as a pressure-up chopper circuit which carries out the pressure up of the electrical potential difference of DC power supply for the circuit which consists of a coil of each phase of a motor, and a switching element of an inverter circuit, and charges a capacitor, and actuation as which an inverter circuit is operated as an original circuit which drives a motor using the electrical potential difference of a capacitor, and it shall have charge of a capacitor, and the function of a motor of a drive with this equipment.
[0004] (Related technique) These people proposed in the application for patent No. 346967 [2000 to] further about the system which arranges DC power supply during the two neutral points of a motor coil. According to this system, the current which flows during the neutral point according to the difference of supply of the current over two motor coils can be controlled, the ratio of the electrical potential difference between the forward negative-electrode bus-bars of an inverter and the electrical potential difference of DC power supply can be controlled, and power conversion in the larger range can be performed.
[0005] Moreover, in this system, two motor coils can also be prepared to one Rota. By this, the large degree of freedom of power conversion can be taken, driving one motor.
[0006]
[Problem(s) to be Solved by the Invention] Although the system of an application for patent No. 346967 [2000 to] is a very efficient system, it is a system which is not in the former. The width of face of the control was wide on the relation which can control independently the middle point potential of two motor coils especially, therefore the management at the time of breaking down an inverter was difficult, and this had to be stopped in order to be system maintenance. On the other hand, when the usual control is continued, the ripple of an output torque becomes large and there is a problem that the electrical potential difference of a capacitor is unmaintainable to a predetermined value.
[0007] This invention is made in view of the above-mentioned technical problem, and aims at offering the drive control unit of the motor which can maintain motorised at the time of failure of an inverter, and its approach.
[0008]
[Means for Solving the Problem] This invention has two motor coils of the independent star to one Rota. It is the motorised control unit which drives the motor which connected between the neutral points of these

motor coil through DC power supply. Two inverters which have two or more arms connected to two or more edges of the motor coil with which it is prepared corresponding to said two motor coils, and each corresponds, It has the control circuit which controls actuation of each arm of these two inverters. Said control circuit When at least one of said the arms breaks down and it becomes impossible to output a current, while controlling other arms and maintaining rotation of the current in two motor coils It is characterized by controlling the arm in two inverters so that it may be in agreement with the current with which the current which flows out of the neutral point of one motor coil flows into the motor coil of another side.

[0009] Thus, when the current supply source to a motor coil becomes impossible by failure of an arm, while maintaining rotation of a motor according to this invention, the current to other motor coils is adjusted so that the current during the neutral point may be maintained to a predetermined thing. Then, while suitable rotation is maintainable at the time of failure of an arm, power conversion is maintainable to a suitable thing.

[0010] Moreover, it is suitable for said two motor coils that only a predetermined include angle can shift a phase and is arranged. This can increase the range at the time of breaking down an arm which can respond.

[0011] Moreover, said two motor coils are formed from the coil of a three phase with which 120 degrees of phases differ at a time mutually, respectively. a1, a2, a3, and the position vector of those for the current which flows in one coil (cos0, sin0), (cos120, sin120), (cos240, sin240), a1, a2, a3, and the position vector of those for the current which flows in the coil of another side Moreover, (cosq, sinq), (cos (q+120), sin (q+120)) (it cos(es) (q+240)), It is referred to as sin (q+240), and q is the phase contrast between both motor coils here. The unit of said trigonometric function It is ** and it is suitable to determine the current of other coils, using as 0 the current and position vector of a coil corresponding to the arm which broke down in three lower formulas on this condition.

[0012]

[Equation 2] $a1\cos0+a2\cos120+a3\cos240+b1\cos q+b2\cos(q+120)+b3\cos(q+240)=r\cos(wt)$

$a1\sin0+a2\sin120+a3\sin240+b1\sin q+b2\sin(q+120)+b3\sin(q+240)=r\sin(wt)$

$a1+a2+a3=-(b1+b2+b3$

However, the angular rate of rotation as an electrical angle of Rota and t of the magnitude of the current component which r commits effective in a motor output torque, and w are time amount.

[0013] By controlling an inverter according to such a formula, when the current supply source to a motor coil becomes impossible by failure of an arm, while maintaining rotation of a motor, the current to other motor coils can be adjusted so that the current during the neutral point may be maintained to a predetermined thing.

[0014] Moreover, the 1st three-phase-motor coil with which this invention is controlled by the 1st inverter, The 2nd three-phase-motor coil controlled by the 2nd inverter, and the capacitor which gives power to said 1st and 2nd inverters, It has the power source connected at the neutral point of said 1st and 2nd three-phase-motor coils. In the motorised control unit equipped with the converter ability which carries out step-down and step-up of said supply voltage by controlling said 1st and 2nd inverters, and carries out adjustable [of the electrical potential difference of a capacitor], in order to realize a desired motorised current The relation required of the current value of each phase of said 1st and 2nd three-phase-motor coils, It has an operation means to calculate each phase current value with which both relation required of the current value of each phase of said 1st and 2nd three-phase-motor coils in order to realize desired step-down and step-up is filled based on a predetermined matrix. When one of said each phases breaks down, it is characterized by transforming said predetermined matrix so that there may be no current of the broken phase and a desired motorised current and the current for step-down and step-up may be outputted from said 1st and 2nd inverters.

[0015] Thus, a motor output is maintainable to a desired thing at the time of failure by changing the matrix for usually acquiring a motorised current in the time of operation with the time of failure.

[0016] Moreover, it is suitable for said 1st three-phase-motor coil and said 2nd three-phase-motor coil to form the double winding motor.

[0017] Moreover, when said failure is detected, it is suitable to set up highly the target electrical potential difference of step-down-and-step-up control. By this, the motor current for a required motor output can be decreased. Then, a motor output is maintainable to a desired thing in the condition of having stopped in the allowable current of an inverter.

[0018] Moreover, it is suitable that said 1st three-phase-motor coil and the 2nd three-phase-motor coil are arranged by the angular difference of values other than 0 times or 60 degrees.

[0019] Moreover, the motorised control approach concerning this invention has two motor coils of the independent star to one Rota. It is the motorised control approach of driving the motor which connected between the neutral points of these motor coil through DC power supply. It is prepared corresponding to said two motor coils, and actuation of each arm of two inverters which have two or more arms connected to two or more edges of the motor coil with which each corresponds is controlled. While supplying a desired motorised current to two motor coils, when at least one of said the arms breaks down and it becomes impossible to output a current While controlling other arms and maintaining rotation of the current in two motor coils, it is characterized by controlling the arm in two inverters so that it may be in agreement with the current with which the current which flows out of the neutral point of one motor coil flows into the motor coil of another side.

[0020]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on a drawing.

[0021] "System configuration" drawing 1 is the block diagram showing the outline of the configuration of the drive system 20 which is 1 operation gestalt. The double winding motor 22 which has two motor coils (henceforth a three phase coil) 24 and 26 with which the star (henceforth Y connection) of this drive system 20 was carried out (henceforth 2Y motor), Two inverter circuits 30 and 32 which are respectively connected to two three phase coils 24 and 26, and share the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, It has the capacitor 38 connected to the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, the cell 40 formed during the neutral point of two three phase coils 24 and 26 of the 2Y motor 22, and the controller 50 which controls the whole equipment.

[0022] Drawing 2 is an explanatory view which illustrates the relation of two three phase coils 24 and 26 of the 2Y motor 22. The 2Y motor 22 consists of Rota where the permanent magnet was stuck on the outside surface, and a stator which only the include angle q shifted two three phase coils 24 and 26 to the hand of cut, and was wound so that it might illustrate to drawing 2 . Except for the point that two three phase coils 24 and 26 are wound, the same configuration as the synchronous generator motor in which the usual generation of electrical energy is possible is carried out. Since only the include angle q has shifted to the hand of cut, the three phase coils 24 and 26 can also consider the 2Y motor 22 to be the motor of a six phase. What is necessary is just to control an inverter circuit 32 so that the three-phase alternating current in which only the coil gap angle q had phase contrast to the three-phase alternating current impressed to the three phase coil 24 by the inverter circuit 30 is impressed to the three phase coil 26 in order to drive such a 2Y motor 22. In addition, the revolving shaft of the 2Y motor 22 is the output shaft of the drive system 20, and power is outputted from this revolving shaft. Moreover, since the 2Y motor 22 is constituted as a generator motor in this operation gestalt, it is inputting power into the revolving shaft of the 2Y motor 22, and can generate electricity by the 2Y motor 22.

[0023] Both the inverter circuits 30 and 32 are constituted by six diodes D11-D16, and D21-D26. [six transistors T11-T16, T21-T26, and] Six transistors T11-T16, and two T21-T26 are arranged at a time in a pair so that it may become a source and sink side to the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, respectively, and each of the three phase coils 24 and 26 of the 2Y motor 22 is connected at the node. The circuit where the transistor configuration of the pair arranged between this positive-electrode bus-bar 34 and the negative-electrode bus-bar 36 is carried out is called an arm. Therefore, inverter circuits 30 and 32 have the arm of a three phase circuit, respectively, are controlling turning on and off of the transistor of each phase arm, and control a motorised current.

[0024] And if the transistors T11-T16 and the ON time amount of T21-T26 which make a pair are controlled by the condition that the electrical potential difference is acting on the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, with the phase contrast of the coil gap angle q, rotating magnetic field can be formed with the three phase coils 24 and 26 of the 2Y motor 22, and the rotation drive of the 2Y motor 22 can be carried out.

[0025] The controller 50 is constituted as a microprocessor centering on CPU52, and is equipped with ROM54 which memorized the processing program, RAM56 which memorizes data temporarily, and input/output port (not shown). For this controller 50 The neutral point current from the current sensor 67 attached at the neutral point of the each phase currents Iu1, Iv1, Iw1, Iu2, Iv2, and Iw2 from current sensors 61-66 and the 2Y motor 22 which were attached in each phase of uvw of the three phase coils 24 and 26 of the 2Y motor 22 The Rota location detected by the angle-of-rotation sensor 68 which detects the electrical potential difference Vc between terminals and the Rota location of the capacitor 38 from a voltage sensor 70 attached in Io and a capacitor 38, (Cell current) The electrical potential difference Vb of the cell 40 detected

by the voltage sensor 69, the command value about the drive of the 2Y motor 22, etc. are inputted through input port. Here, any one is respectively good also as a thing of current sensors 61-63 and the current sensors 64-66 which can omit and uses any one as a sensor only for malfunction detection. Moreover, from the controller 50, the control signal for performing the transistors T11-T16 of inverter circuits 30 and 32 and switching control of T21-T26 etc. is outputted through the output port.

[0026] "Drive current control" In the drive system 20 constituted in this way, switching of the transistors T11-T16 in inverter circuits 30 and 32 is controlled, and the current supplied to the motor coils 24 and 26 is controlled. Especially, with the motor coils 24 and 26, only an include angle q shifts and is arranged. Therefore, according to the current which supplies each phase current supplied to the motor coils 24 and 26 to both motor coils 24 and 26 when only q should shift the phase, Rota can be rotated and the 2Y motor 22 can be driven. According to the torque command value determined according to the amount of accelerator pedal treading in etc., a controller 50 opts for switching of these inverter circuits 30 and 32 by count.

[0027] Usually, technique, such as vector control which divides and calculates an exciting current and a torque current, is used.

[0028] "Power conversion control" With this operation gestalt, a cell 40 is arranged during the two neutral points of the motor coils 24 and 26, and the capacitor electrical potential difference which is the power source of two inverters is controlled by controlling switching of the inverter circuits 30 and 32 which control the electric power supply to the motor coils 24 and 26 again.

[0029] That is, the ratio of the electrical potential difference of the neutral point in the motor coils 24 and 26 and the output voltage of a capacitor 38 is determined by distinguishing between the die length of the "on" period of the top transistors T11, T13, T15, T21, T23, and T25 in inverter circuits 30 and 32, and the "on" period of the bottom transistors T12, T14, T16, T22, T24, and T26.

[0030] That is, in this system, the relation of the neutral point potentials Vz1 and Vz2 of the motor coils 24 and 26 and the supply voltage Vc of inverter circuits 30 and 32, i.e., the output voltage of a capacitor 38, becomes settled in the ratio of the "on" period of the top transistor in inverter circuits 30 and 32, and a bottom transistor, and the potential difference during the two neutral points of the motor coils M1 and M2 is the electrical potential difference Vb (=|Vz1-Vz2|) of a cell 40. Therefore, the both-ends electrical potential difference Vc of Capacitor C will be determined by the ratio (percent modulation) of the "on" period of the top transistor of inverter circuits 30 and 32, and a bottom transistor.

[0031] Moreover, inverter circuits 30 and 32 control the neutral point potentials Vz1 and Vz2 of the motor coils 24 and 26 by carrying out PWM control of the internal transistor. Here, the ratio (percent modulation) of the "on" period of a top transistor and the "on" period of a bottom transistor is the rate of the amplitude of an electrical-potential-difference command value to a round term of the subcarrier which is a triangular wave, as shown in drawing 2 (a) and 2 (b). That is, if an electrical-potential-difference command value is made high, the period when a triangular wave exceeds a command value so much will decrease. And the ratio (namely, percent modulation) of the "on" period of a vertical transistor is determined by making into the "on" period of the top transistor of each phase, and the "off" period of a bottom transistor the period when a triangular wave exceeds a command value. The percent modulation d1 of an inverter INV1 is shown in drawing 2 (a), and the percent modulation d2 of an inverter INV2 is shown in drawing 2 (b).

[0032] Thus, neutral point potential is determined by percent modulation and the ratio of this neutral point potential and a capacitor electrical potential difference is determined by percent modulation. Furthermore, the potential difference of two neutral point potentials is the electrical potential difference Vb of a cell 40. Therefore, the following relation between percent modulation and the electrical potential difference Vc of a capacitor 38 is.

[0033] $Vc=Vb/(d1-d2)$

Then, the electrical potential difference Vc of a capacitor 38 can be determined by controlling the percent modulation d1 and d2 of both the inverter circuits 30 and 32.

[0034] In addition, in the above-mentioned example, the switching transistor was turned on and off as the dish for the dead time to the subcarrier period Ts of an inverter. namely, -- the case of 50% of duty ratio -- a vertical transistor -- 50% -- it was made to carry out period ON. However, in order to abolish the penetration current in a switching period completely, the dead time Td which turns off a vertical transistor both is formed in many cases. In this case, an above-mentioned formula is rewritten as follows and applied.

[0035] $Vc=Vb/\{(d1-Td/Ts)-(d2+Td/Ts)\}$

Thus, when preparing a dead time, the capacitor electrical potential difference Vc can be determined by controlling percent modulation d1 and d2.

[0036] Thus, the electrical potential difference of a capacitor 38 is controllable by the drive of the 2Y motor

22, and control of the percent modulation of inverter circuits 30 and 32.
[0037] "Motor current control" Here, in order to rotate Rota of the 2Y motor 22, total of the current of two motor coils 24 and 26 needs to rotate.
[0038] In this example, the motor coils 24 and 26 of a three phase are formed from the coil with which 120 degrees of phases differ at a time mutually, respectively. The current which flows in each phase coil of the motor coil 24 is set to a1, a2, a3, b1, b2, and b3 as shown in drawing 3 . Moreover, as shown in drawing 4 , the position vector of the motor coils 24 and 26 of a three phase i1= (cos0, sin0), i2=(cos120, sin120) i3=(cos240, sin240), It considers as j1= (cosq, sinq), j2= (cos (q+120)), sin (q+120), and j3= (cos (q+240), sin (q+240)). Here, q is the angular difference between both the motor coil 24 and 26 (phase contrast) here, and the unit of a trigonometric function is **.
[0039] In this case, in order for a motor to take out torque, total of the current of each phase coil needs to rotate. Then, when the angular rate of rotation as an electrical angle of r and Rota is made into r and time amount t for the magnitude of the current component which works effective in a motor output torque, it is required to satisfy a degree type.
[0040]
[Equation 3] a1cos0+a2cos120+a3cos240+b1cosq+b2cos(q+120)+b3cos(q+240)=rcos(wt)
a1sin0+a2sin120+a3sin240+b1sinq+b2sin(q+120)+b3sin(q+240)=rsin(wt)
Moreover, it is necessary to satisfy the following relation about the cell current I required in order to carry out the charge and discharge (step-down and step-up) of the capacitor 38.
[0041]
[Equation 4] a1+a2+a3=Ib1+b2+b3=-I -- it will become a degree type if this formula is arranged.
[0042]
[Equation 5]

$$\begin{pmatrix} \cos 0 & \cos 120 & \cos 240 & \cos q & \cos(q+120) & \cos(q+240) \\ \sin 0 & \sin 120 & \sin 240 & \sin q & \sin(q+120) & \sin(q+240) \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} a1 \\ a2 \\ a3 \\ b1 \\ b2 \\ b3 \end{pmatrix} = \begin{pmatrix} r\cos(wt) \\ r\sin(wt) \\ I \\ -I \end{pmatrix}$$

The current of the left part of this formula has two degrees of freedom, and it is controlled so that total of a current is generally set to 0 using this degree of freedom.
[0043] "Control at the time of failure", next the arm of inverter circuits 30 and 32 break down, and the case where the output of a current becomes impossible is explained.
[0044] First, w phase arm (transistors T25 and T26) of an inverter circuit 32 breaks down, and the case where it becomes impossible to output a current from here is considered. In this case, it is set to b3=0 and an above-mentioned formula can deform as follows.
[0045]
[Equation 6]

$$\begin{pmatrix} \cos 0 & \cos 120 & \cos 240 & \cos q & \cos(q+120) \\ \sin 0 & \sin 120 & \sin 240 & \sin q & \sin(q+120) \\ 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \end{pmatrix} \begin{pmatrix} a1 \\ a2 \\ a3 \\ b1 \\ b2 \end{pmatrix} = \begin{pmatrix} r\cos(wt) \\ r\sin(wt) \\ I \\ -I \end{pmatrix}$$

In this case, although the magnitude of r and I becomes small, since the matrix of left part is a rank 4, the current I for carrying out step-down and step-up of the currents a1, a2, a3, b1, and b2 and capacitor 38 for driving the 2Y motor 22 is realizable with the current of the phase except a current b3.
[0046] Similarly, when w phase arm of inverter circuits 30 and 32 breaks down by failure in both, currents a3 and B3 are set to 0, and a formula can deform as follows.
[0047]
[Equation 7]

$$\begin{pmatrix} \cos 0 & \cos 120 & \cos q & \cos(q+120) \\ \sin 0 & \sin 120 & \sin q & \sin(q+120) \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{pmatrix} \begin{pmatrix} a1 \\ a2 \\ b1 \\ b2 \end{pmatrix} = \begin{pmatrix} r\cos(wt) \\ r\sin(wt) \\ I \\ -I \end{pmatrix}$$

In this case, although the magnitude of r and I becomes small, if it is not q= 0 degree of phase contrast, and

60 degrees, the rank of the matrix of left part is 4 and the cell current I for carrying out step-down and step-up of the capacitor 38 for the current for driving a motor can be realized by each phase currents a1, a2, b1, and b2. That is, when angular difference q arranges in addition to a multiple (0 degree and 60 degrees), the drive of a motor and control of the step-down and step-up of a capacitor 38 are maintainable with the coil current of four phases which remained. In addition, it is actually suitable for angular difference q to set it as 30 degrees, and when the coil current of a polyphase is lost by this, this can be compensated effectively.
[0048] Here, the motor output W0 is expressed with W0=Vc-r-cosphi, when a power-factor is set to cosphi and it sets to Vc a capacitor electrical potential difference (electrical potential difference impressed to an inverter).
[0049] Moreover, since a motor output is decided by energy supplied from the cell of an electrical potential difference Vb, the motor current I is expressed with I=W0/Vb.
[0050] Here, it is referred to as W0=5kW, Vb=50V, and power-factor cosphi=0.8, and if each phase current is searched for about the case of Vc=100,200,300V and the maximum is seen about the case of 2 arm failures of an above-mentioned formula, maximum current will be set to 129.9A, 93.8A, and 81.8A about each case. From this, if the capacitor electrical potential difference Vc to cell voltage Vb is enlarged, it is shown that the phase current (current which flows the transistor (device) of an inverter) decreases also in the time of failure.
[0051] Then, although operation exceeding the allowable-current value (for example, 100A) of a transistor cannot be performed on a specific capacitor electrical potential difference (for example, 100V) at the time of failure, the capacitor electrical potential difference Vc is made high (for example, 200V), the current of a transistor is lowered (for example, 93.8A), it is ****** and operation (RIMPU form operation) in the condition that the arm broke down within the allowable current of a transistor is attained. That is, it becomes possible to maintain to the thing of a request of a motor output and to perform RIMPU form operation by making the capacitor electrical potential difference Vc high.
[0052] Thus, according to the system of this operation gestalt, when the arm of inverter circuits 30 and 32 breaks down, a part for the broken current of a phase can be compensated and driven according to the motorised current from other arms. Therefore, a torque ripple is increased or the thing to which capacitor 38 electrical potential difference deviates from normal values and for which thing prevention is carried out and operation of a motor is continued becomes possible.
[0053]
[Effect of the Invention] As explained above, when the current supply source to a motor coil becomes impossible by failure of an arm, while maintaining rotation of a motor, according to this invention, the current during the neutral point can be maintained to a predetermined thing by adjusting the current to other motor coils which are not out of order.

[Translation done.]

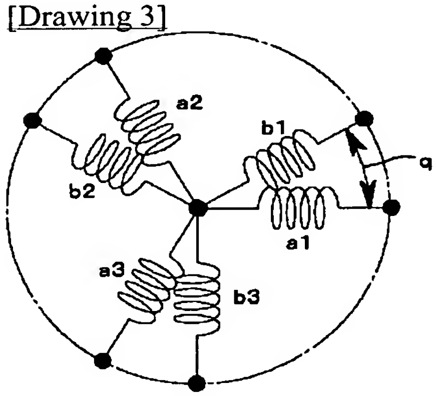
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

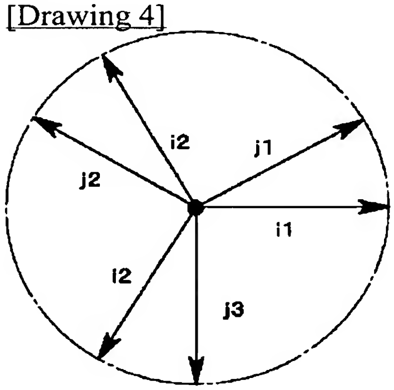
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

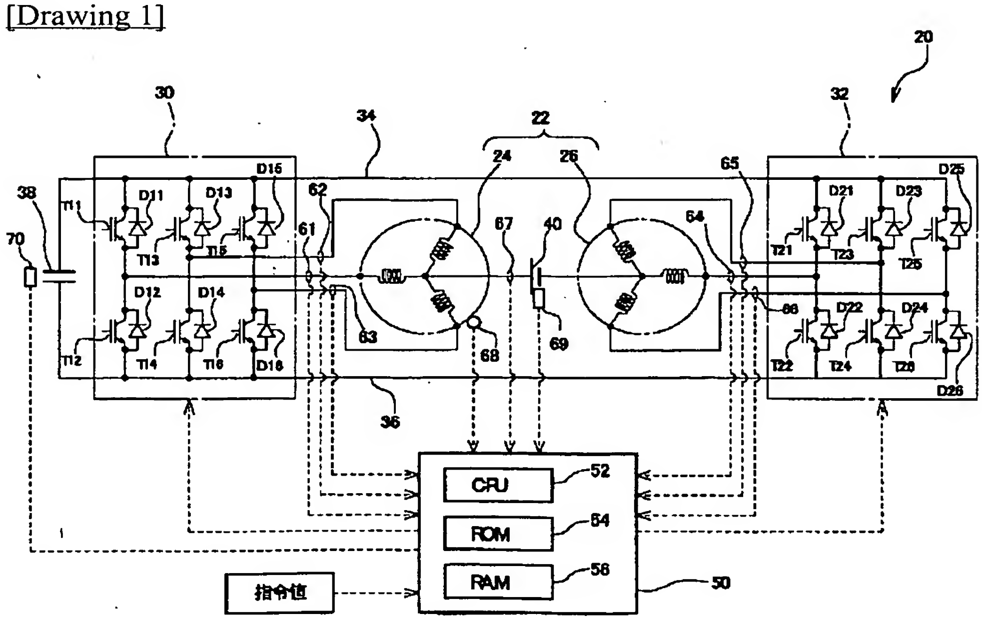
[Drawing 3]



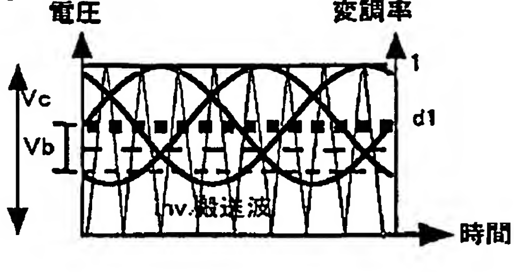
[Drawing 4]



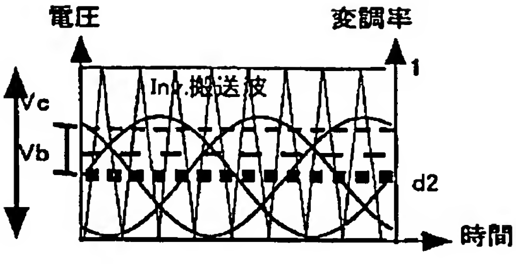
[Drawing 1]



[Drawing 2]



(a)



(b)

[Translation done.]